Suggestions for Improving the Manufacture of Optical Glass. By James Nasmyth, Esq.

Mr. Nasmyth, after remarking, for our encouragement, that the problem is possible, since large discs of homogeneous glass are made elsewhere, expresses his conviction that the proper materials in sufficient purity are at our command, and that the difficulty is in the mode of effecting perfect combination and vitrification.

He proposes to carry the heat of the furnace to the highest practicable degree, thus insuring perfect fusion and fluidity, and then, by maintaining the heat for a considerable time, to give the particles time to arrange themselves in their order of density. He would then lower the heat so gradually as to avoid disturbing their arrangement, but not so slowly as to endanger its vitreous quality. The melting-pots should be cylindrical in form, and as deep as prudence will permit. The mass, when cool, is to be sawn across in parallel slices. In this way Mr. Nasmyth conceives that discs nearly homogeneous would be procured, and at any rate that the density would be uniform through each horizontal section, which perhaps would be sufficient for optical purposes. If there be any tendency to unite in definite proportions, it is clear that the circumstances described would favour the combination.

Without venturing to give a positive opinion on such a subject, the method seems founded on rational principles. It is high time some vigorous attempt should be made to manufacture optical glass in this country. The foreign supply is scanty, and often of indifferent quality. At Munich, *finished* object-glasses, *only*, are furnished; the price is high, and the telescopes not always of corresponding quality. It is nearly a century since Dollond discovered the principle of achromatism, and constructed his admirable telescopes; and it may be doubted whether the manufacture of optical glass has since advanced one step in this country. The great bar to improvement, the vexatious excise laws, is removed; and the first person who can restore this country to her original pre-eminence in optical glass-making, will not merely derive a large pecuniary recompense, but be entitled to the gratitude of every lover of astronomical science.

At the close of the meeting Mr. Sheepshanks gave a short account of the origin and construction of instruments on the *repeating* principle, expressing an opinion that, though the improved construction and division of astronomical and geodesical instruments had in later years taken away much of the original value of this invention, yet that, under some circumstances, a repeating stand for a theodolite or an astronomical circle repeating in altitude might be useful. When the causes of error in measuring an angle, terrestrial or celestial, are separately considered, the sum of the errors of division and of reading off will in some cases be much larger than the error of bisecting the object or of reading off the level. Whenever this is so, then, *supposing no fresh error to be introduced*, the repeating principle may be advantageously applied,

since the errors of division and reading off are divided by the *whole* number of observations, and not by the *square root* of the number, as is the case in non-repeaters.

The defect most to be feared in repeating instruments is the slipping of a part which should be fixed while another part is moved. This may probably be avoided in the *repeating stand* for a theodolite, by making the lower motion exceedingly heavy while the upper motion is exquisitely light, and by affixing the clamp of the stand at as large a distance as may be from the centre of motion. By measuring the angle twice over, first moving the theodolite and stand the same way, and again moving them the contrary way, any error from slipping will be detected. The coincidence of results by the two methods will be a satisfactory test of their truth.

When the repetition is in altitude, the level, *if attached to the circle*, is a sufficient protection against slipping. It is, perhaps, owing to the mistake of fixing the level to the vertical axis, and polishing the limb so highly that the clamp could not bite hard, that the repeating circle lost much of its reputation.

In Borda's circle, the clamp for moving the vertical circle is inconveniently placed; *two* observers are required (unless the support of the instrument is immoveable), and the telescope, in the original construction, is very loosely held. The last fault is easily amended, and by sacrificing the motion round the upper axis (which is utterly useless in an astronomical instrument), a convenient situation may be given to the circle clamp. Mr. Sheepshanks exhibited a form of the instrument which can be used single-handed. The line of sight of the telescope is turned by a prism down the tube which forms the axis of the vertical circle; thus the observer, without changing his position, can read off the level immediately after the bisection of the star; but the instrument has not as yet been tested experimentally.

To measure the effect of flexure in the telescope, which seems to be the only *fixed* source of error in this class of instruments, Mr. Sheepshanks proposes either to measure the angle of 180° between two collimating telescopes, after Bessel's method, or to observe the circum-meridian altitudes of the same star in three fashions. First in the ordinary manner, in which the flexure tells one way; secondly, observing the star in mercury, where the nadir distances will be affected by flexure to the same amount but the *contrary* way from the zenith distances; and thirdly, by stepping from the star seen directly to the star seen by reflexion, which is not affected by flexure at all. A careful set of observations would probably give the constant of flexure with great nicety.

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